(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 836 247 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
15.04.1998 Bulletin 1998/16

(51) Int. Cl.[6]: **H01R 17/12**

(21) Application number: **97117079.0**

(22) Date of filing: **02.10.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **11.10.1996 US 730526**

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(54) Impedance matched cable assembly

(57) A terminating connector (22) for a data transmission cable (20), wherein the cable (20) is of a known characteristic impedance and is of the type having a signal carrying conductor (26) and a shield (24). The connector (22) is typically arranged to mate with a complementary connector of a backplane. An overmolded subassembly (46) of the connector (22) includes a first terminal (32) electrically coupled at one end thereof to the shield (24), and a second terminal (34) electrically coupled at one end thereof to the signal carrying conductor (26). A dielectric insert (44) is disposed between the first and second terminals (32, 34). The insert (44) is dimensioned and has a dielectric constant such that the characteristic impedance of the subassembly (46) substantially matches the characteristic impedance of the cable (20). The subassembly (46) may be secured to a surrounding housing (28).

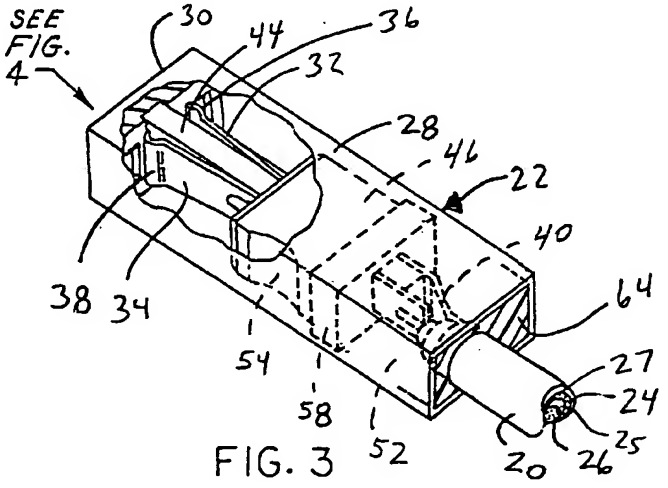

FIG. 3

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Description

TECHNICAL FIELD OF THE INVENTION

The present invention relates generally to electrical connectors used in high speed data transmission, and more particularly to a connector having improved impedance characteristics.

BACKGROUND OF THE INVENTION

When transmitting high speed data signals through a conductive transmission medium, the integrity of the received signals depends on the impedance over the signal path. In general, impedance mismatches in a transmission path cause signal reflection, which leads to signal losses such as reduction in signal amplitude, cancellation of certain signals, and so on. Accordingly, the more consistent the impedance over the path, the better the integrity of the received signal.

The wire portion of the conductive transmission medium, which, for example, may be a coaxial cable, provides a signal path having a very consistent characteristic impedance. Moreover, the physical construction of the wire allows the impedance to be selected, e.g., one cable may be constructed to have an impedance of 75 ohms, while another has an impedance of 50 ohms.

However, the terminating connector that connects the signal-carrying wire to the next destination for the signal is not well controlled with respect to impedance, and typically varies from the cable's impedance by a substantial amount. In particular, in a standard two millimeter connector assembly, the impedance of the connector is notorious for being poorly matched with the controlled-impedance cable that the connector is terminating. This reduces the integrity of signals received therethrough, resulting, for example, in numerous transmission errors and/or limited bandwidth.

OBJECTS AND SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an apparatus and method that improves the integrity of signal transmission by improving the impedance match between an electrical terminating connector and a data transmission cable terminated thereby.

It is a related object to provide a terminating connector that substantially matches the impedance of the cable.

Another object is to provide a connector as characterized above that is compatible in size and shape with standardized connector specifications.

Yet another object is to provide an apparatus of the above kind that employs a relatively simple and economical manufacturing method, while providing a sturdy and reliable connector.

Briefly, the present invention provides an apparatus for terminating a data transmission cable and a method for constructing same. The cable is of a known characteristic impedance and is of the type having a signal carrying conductor and a shield. The apparatus is embodied in a connector comprising a subassembly, the subassembly including a first terminal arranged for electrically coupling at one end to the shield. A first contact is disposed at the opposite end of the terminal. The subassembly further includes a second terminal arranged for electrically coupling at one end to the signal carrying conductor, and has a second contact at an opposite end thereof. A dielectric insert is disposed between the first and second terminals, the insert being dimensioned and having a selected dielectric constant to provide a characteristic impedance of the subassembly that substantially matches the characteristic impedance of the cable. A housing is provided, and has an interior region dimensioned to receive the subassembly from one end such that the first and second contacts are electrically accessible from an opposite end of the housing. The subassembly may be secured to the housing, such as by epoxy or the like.

Other objects and advantages will become apparent from the following detailed description when taken in conjunction with the drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a side view illustrating a data transmission apparatus constructed according to the invention having a cable shown with terminating connectors at both ends thereof;

FIG. 2 is a top view of the apparatus of FIG. 1;

FIG. 3 is a partial cut-away, perspective view illustrating the terminating connector coupled to one end of a cable via a subassembly secured to a housing;

FIG. 4 is an end view illustrating apertures in the housing for providing electrical access to the terminals;

FIG. 5 is a side view of the terminating connector in partial cross-section showing the subassembly secured to the housing;

FIG. 6 is a top view representative of stamped terminal portions for constructing the connector;

FIG. 7 is a side view of FIG. 9;

FIG. 8 is an exploded view illustrating a method of constructing the subassembly components;

FIG. 9 is a representation of the terminals with a dielectric insert therebetween and coupled to the cable prior to overmolding into a completed subassembly;

FIG. 10 is a perspective view showing the subassembly prior to securing to the housing;

FIG. 11 is a side view similar to FIG. 1 illustrating an alternate data transmission apparatus having multiple signal-carrying conductors within the cable;

FIG. 12 is a top view of the apparatus of FIG. 11;

FIG. 13 is a partial cut-away, perspective view illus-

trating a terminating connector with multiple signal carrying conductors of FIGS. 11-12; and

FIG. 14 is an end view illustrating apertures in the housing for providing electrical access to the terminals of the connector of FIGS. 11-13.

While the invention is amenable to various modifications and alternative constructions, certain illustrated embodiments thereof are shown in the drawings and will be described below in detail. It should be understood, however, that there is no intention to limit the invention to the specific forms disclosed, but on the contrary, the intention is to cover all modifications, alternative constructions, and equivalents falling within the spirit and scope of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning to the drawings and referring first to FIGS. 1 and 2, there is shown a cable 20 having an electrical terminating connector generally designated 22 at each end thereof constructed in accordance with the invention. As best shown in FIG. 8, the cable 20 is of the type having a shield 24 and a signal carrying conductor 26, and has a known characteristic impedance, e.g., 50 ohms. A dielectric layer 25 electrically insulates the shield 24 from the signal carrying conductor 26, and a dielectric sheath 27 covers the shield 24. Such cables are typically used in high speed data transmission such as in telecommunications applications or applications involving the transmission of computer signals.

As best shown in FIGS. 3, 5 and 10, the components of each connector are surrounded by a protective housing 28, the housing 28 adapted for plugging into a backplane assembly or the like (not shown). The housing 28 may be made from molded plastic or other suitable material. A mating end 30 of the housing 28 includes two openings 31, 33 (FIG. 4) providing access to first and second terminals 32, 34 of the connector 22, such that complementary terminals or the like of a backplane connector may mate therewith.

As best shown in FIG. 5, the first and second terminals 32, 34 are resilient at respective contact points 36, 38 thereof so as to be deflectable by such complementary terminals, thereby ensuring adequate electrical contact. As also shown, the other end 40 of the first terminal 32 is electrically coupled to the shield 24 while the other end 42 of the second terminal 34 is electrically coupled to the signal carrying conductor 26 of the cable.

In accordance with one aspect of the invention, as shown in FIGS. 3 and 5, the first and second terminals 32, 34 have a dielectric insert 44 sandwiched therebetween. The dielectric insert 44 is dimensioned and has a dielectric constant selected such that the impedance through the connector 22 substantially matches the impedance of the cable 20. The separation and area of the terminals adjacent the dielectric insert 44, along with the dielectric constant of the dielectric insert 44, influence the characteristic impedance by generally altering the connector capacitance, i.e., ($C = \varepsilon A / d$) where ε is the dielectric constant, A is the area of the terminals and d is the separation between the terminals).

One material found suitable for the dielectric insert 44 is RT Duroid, wherein the connector 22 is constructed to terminate a 50 ohm impedance cable and is a two millimeter (.0787 ± .001 inches) type, i.e., as specified by the terminal separation W as shown in FIGS. 4 and 5. In such a connector, the thickness of the insert is .762 millimeters (.030 ± .001 inches). Other materials, including ceramics, have been found to provide desired impedances for this size connector, although ceramics are generally less durable. Of course, alternate materials are feasible, as determined by the desired impedance and the dimensions of the connector.

For structural purposes, the terminals 32, 34 and dielectric insert 44 are overmolded into a subassembly 46 as best shown in FIG. 10. The subassembly 46 is dimensioned such that it completely fits into the inner region 52 (FIG. 10) of the tubular dielectric housing 28. A recess 54 may be optionally formed in the subassembly 46 to facilitate proper insertion and particularly to serve as an indicator of proper polarity. The housing 28 is open at one end 56 (FIG. 10), and the subassembly 46 includes a wider end portion 58. The wider end portion 58 tightly, but slidably fits into the inner region 52 of the housing 28. A protrusion 60 (FIG. 5) or the like on the inner wall 62 of the housing may be provided, the protrusion 60 limiting the depth of insertion into the housing 28 from that end. As can be appreciated, this locates the terminals 32, 34 in the proper position (with respect to insertion depth) for making subsequent electrical contact.

To secure the sub-assembly 46 to the housing 28, the subassembly 46 is fastened to the housing 28 with an adhesive material such as epoxy 64. To facilitate the epoxying operation, the wider end portion 58 of the subassembly 46, which is only slightly smaller than the inner region of the housing 52, serves as a stop surface, preventing epoxy from reaching the contacts 36, 38 to ensure that electrical contact at the contact points is not impaired. The epoxy 64 further serves to strain relieve the connections between the terminals 32, 34 and the cable shield 24 and center signal conductor 26. Other suitable materials may include resins, polyurethanes, plastics and so on, and may be cured in any number of ways.

In general, a metered amount of liquid epoxy 64 is dispensed in a known manner to fill the rearwardmost space of the inner region 52 of the housing 28, and allowed to (or caused to) properly cure. Once cured, the housing 28 and subassembly 46 become a unitary, generally permanent, structure. Of course, other methods of securing the subassembly to the housing are feasible, such as described in copending U.S. Patent Appli-

cation entitled "Impedance Matched Cable Assembly Having Latching Subassembly," Attorney Docket No. 96-039, assigned to the assignee and having the same inventors as named herein.

To construct the connector 22, the terminals 32, 34 are stamped, formed and trimmed from sheet metal 69 as generally shown in FIGS. 6 and 7. The terminals 32, 34 are also typically plated as desired. Such stamping, forming, trimming and plating operations are well understood, and are not discussed in detail herein. During assembly, the trimming is such that the two terminals 32, 34 remain temporarily connected to one another by a sheet metal tab 70, shown in FIGS 6 and 7 and in phantom in FIG. 8. Such a connection facilitates assembly by keeping the terminals 32, 34 aligned with one another at a desirable separation distance.

For simplicity, the connector 22 will be described from the perspective of having a forward end that plugs into a backplane, and a rearward end that is electrically coupled to the cable 20. Similarly, the prepared (stripped) end of the cable 21 may be considered the forward end of the cable, i.e., the forward end of the cable is electrically coupled to the rearward end of the connector 22. Of course, the forward and rearward terminology is arbitrary and does not limit the invention, as the apparatus may be oriented in any direction with signals being transmitted either or both directions therethrough.

As shown in FIG. 8, the forward end 21 of the cable 20 is prepared, i.e., stripped in a known manner, such that the center, signal carrying conductor 26 extends foremost, with a portion of its insulated layer 25 extending to a lesser distance to insulate the signal carrying conductor 26 from the stripped braided portion 24. The braided shield 24 is then electrically coupled, e.g., soldered or welded, to the rearward end of the first terminal 32, while the center, signal-carrying conductor 26 is electrically coupled, e.g., soldered or welded, to the second terminal 34. In the exemplified embodiment shown herein, the first terminal 32 is slightly bent for reaching the braided shield 24 to facilitate the soldering or welding. The second terminal 34 is relatively straigt and slightly shorter to accommodate the lengthier center conductor 26.

In another step, as represented in FIG. 8, the dielectric insert 44 is inserted between the terminals 32, 34. The resiliency and separation of the terminals may be such that the insert is held in place, however this is not necessary to the invention. When assembled, the tab 70 shown in phantom in FIG. 8 is removed, such that at this moment the connector generally appears as in FIG. 9. The terminals 32, 34, and insert 44 are then overmolded into the subassembly 46 shown in FIG. 10. Lastly, when cured, the subassembly 46 is inserted into the housing 28 wherein it is secured (e.g., epoxied) as described above.

Finally, as best shown in FIGS. 11-14, similar connectors 122 may be arranged for terminating cables 120 having multiple signal carrying conductors 126, 226. For simplicity, in FIGS. 11-14, like components performing like functions to those in FIGS. 1-10 are numbered exactly one-hundred higher than their numbered counterparts of FIGS. 1-10. Where necessary in FIGS. 11-14, when two such like components are provided instead of one, each of the second such components are numbered exactly two-hundred higher than their numbered counterparts in FIGS 1-10.

Thus, as shown in FIG. 13, the braided shield 124 may be coupled to common terminals 132, 232 for mating with a single complementary terminal of a suitable complementary backplane connector. To this end, wire-like leads 80, 82 or the like may be used to facilitate the connection, or the terminals 132, 232 may be slightly bent as described previously. Of course, the shield 124 may only be coupled to one of the two terminals, and only one such ground terminal may be actually necessary (e.g., terminal 132). Similarly, such a connector 122 may provide two separate terminals for contacting the shield, i.e., have four separate contact points.

In any event, the center conductors 126, 226 are electrically coupled to the terminals 134, 234, respectively. A first dielectric insert 144 is inserted between terminals 132 and 134, while a second dielectric insert 244 is inserted between terminals 232 and 234. In the manner described above, the dielectric inserts 144, 244 and terminals 132, 232, 134 and 234 are overmolded into a subassembly 146. As before, the subassembly 146 is inserted into and secured to an appropriately-configured housing 128. As can be appreciated, the housing 128 provides as many openings 131, 133 and 233 as necessary to provide access to the multiple terminals.

As can be seen from the foregoing detailed description, there is provided an apparatus and method that improves the integrity of signal transmission by improving the impedance match between an electrical terminating connector and a data transmission cable terminated thereby. The terminating connector substantially matches the impedance of the cable, and the connector is compatible in size and shape with standardized connector specifications. The apparatus employs a relatively simple and economical manufacturing method, and provides a sturdy and reliable connector.

Claims

1. An electrical terminating connector (22) for a data transmission cable (20), the cable (20) of a known characteristic impedance and of the type having a signal carrying conductor (26) and a shield (24), the connector (22) comprising, a subassembly (46) including a first terminal (32) arranged for electrically coupling at one end thereof to the shield (24) and having a first contact (36) at an opposite end thereof, a second terminal (34) arranged for electri-

cally coupling at one end thereof to the signal carrying conductor (26) and having a second contact (38) at an opposite end thereof, and a dielectric insert (44) disposed between the first and second terminals (32, 34), the dielectric insert (44) being dimensioned and having a selected dielectric constant to provide a characteristic impedance of the subassembly (46) that substantially matches the characteristic impedance of the cable (20), a housing (28), the housing (28) having an interior region (52) dimensioned to receive the subassembly (46) from one end of the housing (28) such that the first and second contacts (36, 38) are electrically accessible from an opposite end (30) of the housing (28), and means (64) for securing the subassembly (46) to the housing (28).

2. The connector of claim 1 wherein at least part of the subassembly (46) is overmolded into a unitary structure.

3. The connector of claim 1 wherein the dielectric insert (44) comprises RT Duroid.

4. The connector of claim 1 wherein the dielectric insert (44) comprises ceramic material.

5. The connector of claim 1 wherein the means (64) for securing the subassembly (46) to the housing (28) includes epoxy.

6. The connector of claim 5 wherein at least one portion (58) of the subassembly (46) is dimensioned to fit in the interior region (52) of the housing (28) such that said portion (58) impedes the flow of epoxy.

7. The connector of claim 1 wherein the housing (28) includes means (60) for limiting depth of subassembly (46) insertion.

8. The connector of claim 1 wherein the cable has a plurality of signal carrying conductors (126, 226), and further comprising a third terminal (234) arranged for electrically coupling at one end thereof to a second signal carrying conductor (226) and having a third contact at an opposite end thereof.

9. An apparatus for transmitting electronic data therethrough, comprising:

a transmission cable (20) of a known characteristic impedance, the cable (20) including a signal carrying conductor (26) and a shield (24); and

an electrical terminating connector (22), the connector (22) comprising,

a subassembly (46) including a first terminal (32) electrically coupled at one end to the shield (24) and having a first contact (36) at an opposite end thereof, a second terminal (34) electrically coupled at one end to the signal carrying conductor (26) and having a second contact (38) at an opposite end thereof, and a dielectric insert (44) disposed between the first and second terminals (32, 34), the dielectric insert (44) being dimensioned and having a selected dielectric constant to provide a characteristic impedance of the subassembly (46) that substantially matches the characteristic impedance of the cable (20);

a housing (28), the housing (28) having an interior region (52) dimensioned to receive the subassembly (46) from one end of the housing (28) such that the first and second contacts (36, 38) are electrically accessible from an opposite end of the housing (28); and

means (64) for securing the housing to the subassembly.

10. The apparatus of claim 9 wherein at least part of the subassembly (46) is overmolded into a unitary structure.

11. The apparatus of claim 9 wherein the dielectric insert (44) comprises RT Duroid.

12. The apparatus of claim 9 wherein the dielectric insert (44) comprises ceramic material.

13. The apparatus of claim 9 wherein the means (64) for securing the subassembly (46) to the housing (48) includes epoxy.

14. The connector of claim 13 wherein at least one portion (58) of the subassembly (46) is dimensioned to fit in the interior region (52) of the housing (28) such that said portion (58) impedes the flow of epoxy.

15. The connector of claim 13 wherein the epoxy surrounds a region wherein the first terminal (32) is electrically coupled at one end to the shield (24) and wherein the second terminal (34) is electrically coupled at one end to the signal carrying conductor (26).

16. The connector of claim 1 wherein the housing (28) includes means (60) for limiting depth of subassembly (46) insertion.

17. The apparatus of claim 9 wherein the cable has a plurality of signal carrying conductors (126, 226), and further comprising a third terminal (234)

arranged for electrically coupling at one end thereof to a second signal carrying conductor (226) and having a third contact at an opposite end thereof.

18. A method of constructing an apparatus for transmitting electronic data therethrough, comprising the steps of, providing a transmission cable (20) of a known characteristic impedance, the cable (20) including a signal carrying conductor (26) and a shield (24), electrically coupling a first terminal (32) at one end thereof to the shield (24), electrically coupling a second terminal (34) at one end thereof to the signal carrying conductor (26), inserting a dielectric material (44) between the first and second terminals (32, 34), the dielectric material (44) being dimensioned and having a selected dielectric constant to provide a characteristic impedance of the apparatus subassembly (46) that substantially matches the characteristic impedance of the cable (20), overmolding at least part of the dielectric insert, (44), the end of the first terminal (32) coupled to the shield (24), and the end of the second terminal (34) coupled to the signal carrying conductor (26) into a subassembly, (46), and inserting the subassembly (46) into a housing (28), and securing the subassembly to the housing.

19. The method of claim 18 wherein the step of securing the subassembly (46) to the housing (28) includes the step of delivering an amount of epoxy (64).

20. The method of claim 18 wherein the cable has a plurality of signal carrying conductors (126, 226), and further comprising the step of electrically coupling a third terminal (234) at one end thereof to a second signal carrying conductor (226).

21. The method of claim 18 further comprising the step of stripping the cable (20) such that the signal carrying conductor (26) and shield (24) are exposed for electrically coupling to the respective terminals (32, 34).

22. The method of claim 18 further comprising the steps of stamping and forming the first and second terminals (32, 34).

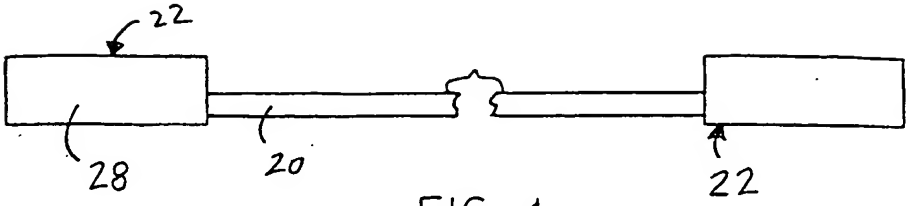

FIG. 1

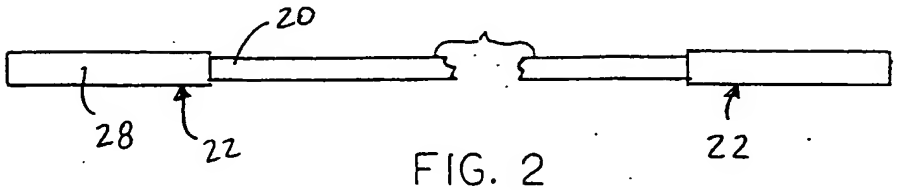

FIG. 2

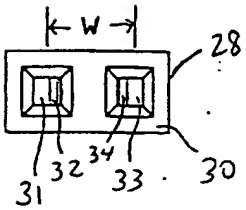

FIG. 4

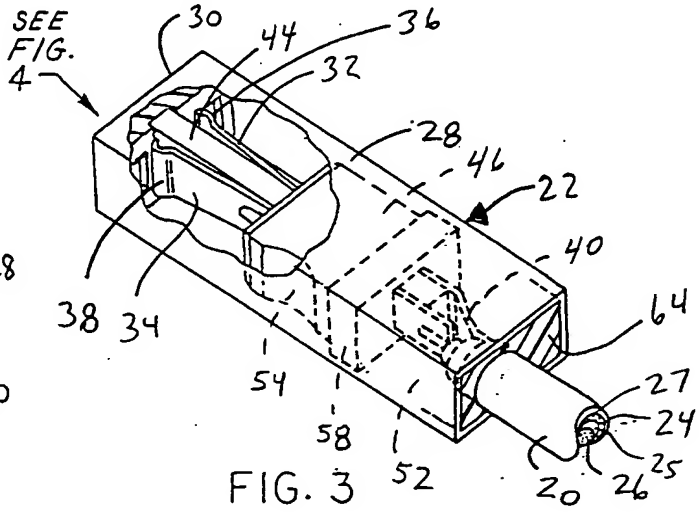

FIG. 3

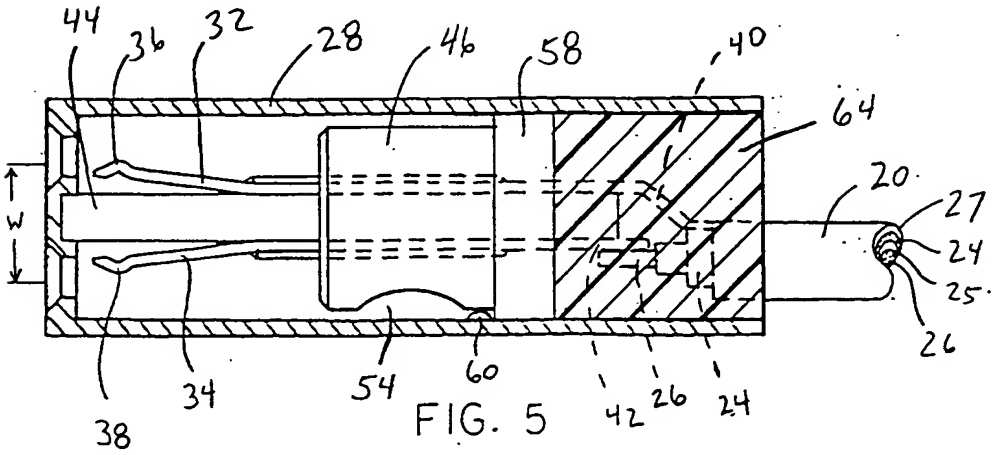

FIG. 5

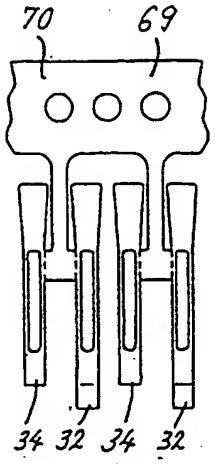

FIG. 6

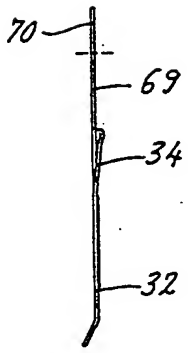

FIG. 7

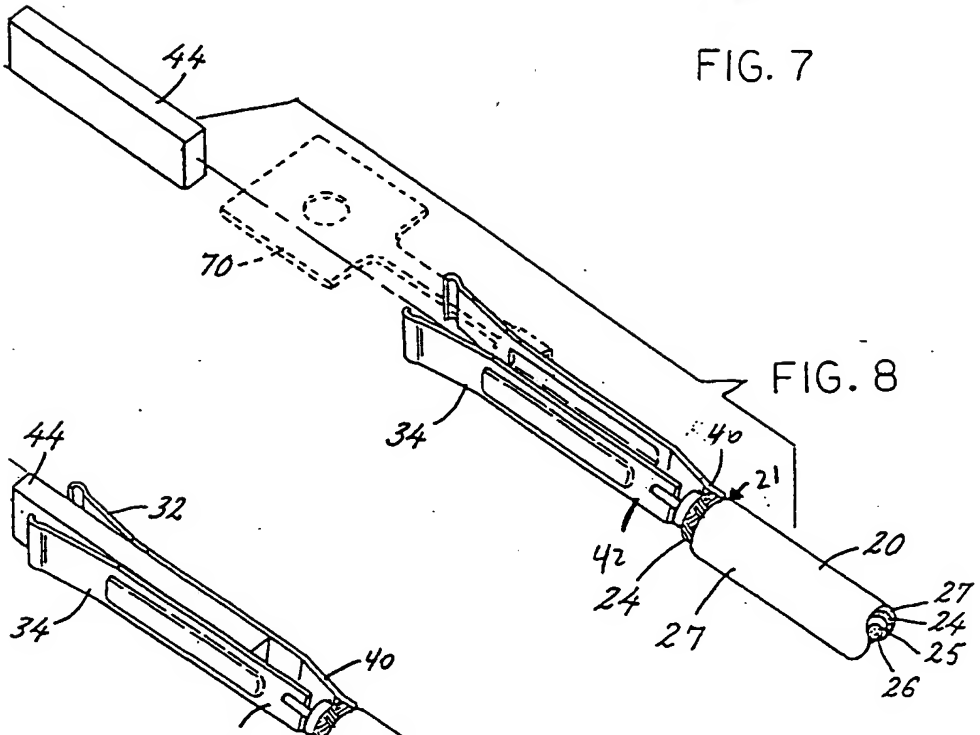

FIG. 8

FIG. 9

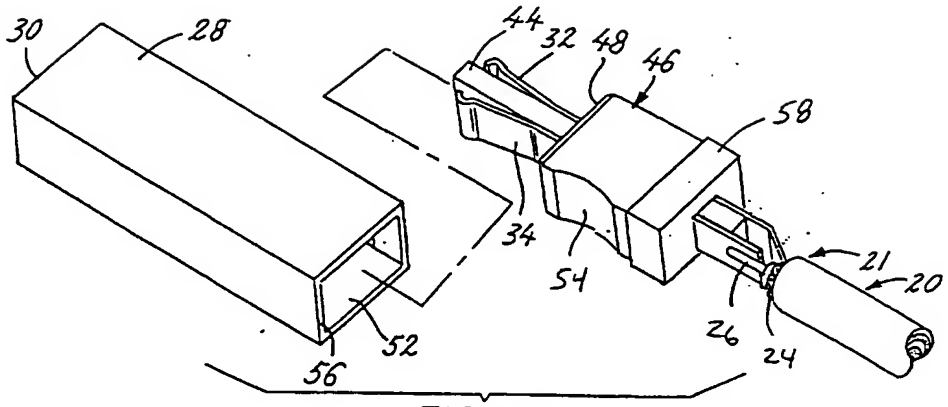

FIG. 10

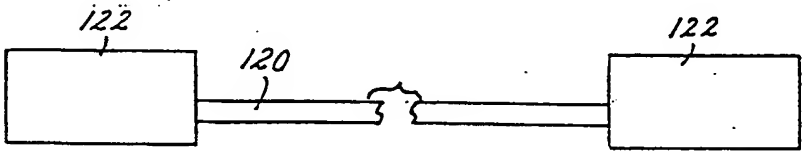

FIG. 11

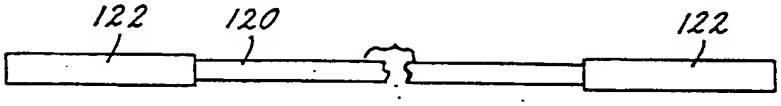

FIG. 12

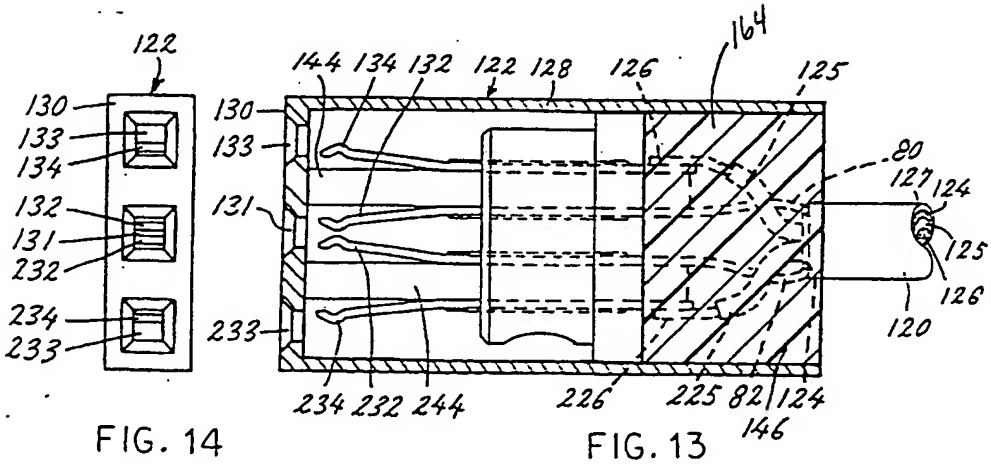

FIG. 14

FIG. 13